Indoor air pollution and its health impact: a case study of Aligarh city, India

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Abstract

The environmental concern for air pollution has largely been focused on the question of pollution outdoors. However the attention of scientists has shifted to the quality of air indoors. The indoor air pollutants are nearly the same as that of the outdoor ones. However in some instances the concentration of indoor pollutants exceeds the standard set for the outdoors. These pollutants reach such a high level although they are emitted in small volumes but they cannot escape easily from the buildings due to lack of proper ventilation. Indoor air pollution is more harmful and poses greater health hazards because on average a person spends nearly 16 to 18 hours indoors. Keeping these points in mind, it was thought worth studying the indoor air pollution and its impact on the health of the people in a medium size city of India, i.e. Aligarh with a population of nearly 0.6 million by the end of 2001. This paper is based on a comprehensive household survey. About 3.15 per cent (2,185) households were sampled for this study. The sampled households were divided into five income groups. An attempt was made to see the income-wise indoor air pollution and its health impact on the sampled residents of Aligarh city. The paper addresses the use of various fuels for cooking, place of cooking, indoor smoking, outside smoke coming inside the house, ventilation in the house and also the floor space per person in the sleeping rooms. A relationship between the indoor air pollution and respiratory diseases was drawn using the SPSS 7.5 for significance test by Spearman. The study shows that indoor air pollution, crowding and humidity contributes to the respiratory problems in more than 50 per cent of the sample residents of Aligarh city and if the economic conditions improve then the chances of air pollution and health impact is also likely to be reduced.

Keywords: Indoor air pollution, field survey, income group, Aligarh city, SPSS 7.5, respiratory diseases.
1 Introduction

The environmental concern for air pollution has been largely focused on the question of pollution outdoors. Recently however attention has been shifted on the quality of air indoor i.e. within the buildings because on an average people spend nearly 16-18 hours inside the office or inside the house. The indoor air pollutants are nearly the same as that of out door one e.g. Sulphur dioxide, Carbon monoxide, Nitrogen oxide, Formaldehyde, Asbestos, Polycyclic Organic matters and Particulates. In some instances the concentration of indoor pollutants exceeds the standard set for the outdoor e.g. the concentration of nitrogen dioxide inside the house is nearly five times higher than the outside [1]. These pollutants reach such a high level although they are emitted in small volume but they can not escape out easily from the buildings due to lack of proper ventilation in most of the houses. Indoor air pollution is more harmful and poses greater health hazards because of long indoor exposure to air pollutants.

One of the most important environment related health problem the people of Aligarh city facing is the respiratory disease. It comes on the forth place after diarrhea/ dysentery, malaria, and jaundice. In poor cites, environmental problems tend to remain close to home, where crowding, smoky kitchens, garbage, pests, unsanitary food and dirty water continue to plague the inhabitants day in and day out [2]. Viral agents account for the majority acute respiratory infection. It is transmitted by air borne particulates, droplets or by physical indoor crowding, poor ventilation and lack of sunlight increases the danger of cross infection. Exposure to air borne irritants such as smoke from cooking fires can predispose the body to the respiratory disease and increases the likelihood of secondary infection [2].

Acute Respiratory Infection (ARI) is particularly hazardous for children, especially infants and elderly. Every year ARI in young children is responsible for an estimated 4.1 million death worldwide. It is estimated that India, Bangladesh, Nepal and Indonesia together account for 40 per cent of global ARI mortality [3]. Survey carried out to investigate use of fuel and exposure to air pollution while cooking and health symptoms among urban housewives in Maputo. The study shows that exposure to fuel pollution was higher among wood users than users of other fuels, and more health symptoms were reported. The study further suggests that the wood use should be discouraged.

The suspended particulate matter that enters the human lung causes temporary damage initially and later become chronic at a longer period of exposure [4]. The health of hundreds of million people is threatened particularly in the city area due to smoky indoor air caused by the use of smoky cooking fuels such as wood, coal, and dung cake [5]. This paper covers the indoor air pollution and its impact on the health particularly with reference to respiratory diseases of the people in a medium size but fast growing city of India i.e. Aligarh. The paper is not designed explicitly to provide a basis for epidemiological analysis, nonetheless, most of the relevant variables are available, and the results are indeed revealing.
2 Study area: Aligarh city

Aligarh is a medium size town of North India, which lies in the shadow of country's capital New Delhi on 27° 53’ N latitude and 78° 4’ E longitude (Figure 1). The city's population has increased from 0.25 millions in 1971 (Census of India 1991) to 0.6 million in 2001 (Municipal Board 2001). Here clean water is hard to get solid wastes are lying along roads, drains are open, paths are narrow and roads have many potholes. Most of the old markets are crowded noisy and smoky [6]. The city has a distinct demarcation between the old and the new part. The old part of the city spreads over 39 wards in the west. It is very congested and has the highest population densities. The new parts of the city spread over 21 wards in the east. It appears remarkably clean but now with the springing up of new residential colonies and commercial complexes this part is also becoming congested and dirty [7].

Topographically the district of Aligarh represents a shallow trough, saucepan shape like appearance with the River Ganga in the northeast and River Yamuna in the northwest forming the highland peripheries. Aligarh city lies in this center of the low-lying tract (Figure 1). Because of lack of natural drainage, rainwater and wastewater collects in the low-lying areas of the city. There is no outlet of water. The city not only gets submerged during the rainy season but also some parts remain submerged all the year round because of imperfect natural drainage.
3 Data and methodology

3.1 Questionnaire

The data were collected mainly from primary sources. The methods used include:

- site observation, which means the survey of residential colonies and industrial areas
- survey of entire city, which has sixty municipal wards
- survey of households with a closed end structured questionnaire applicable to Indian cities

The questionnaire used for this study was developed with the help of questionnaires used in similar studies in Accra Metropolitan Area, Jakarta, and Sao Paulo, etc. [7-15].

The questionnaire covered the following aspects:

- Floor space per person in sleeping rooms (< 10 square feet, 10-20 sq. ft, > 20 sq. ft.)
- ventilation condition in the house (yes/no, if yes! proper or not proper)
- place of cooking (proper kitchen/open air/in verandah/in the multipurpose room)
- fuels for cooking (LPG/wood/coal/kerosene/saw dust/ dung cake/dry leaves)
- smoke from neighborhood coming inside the house (yes/no)
- smoking inside the house (yes/no)

Data regarding respiratory diseases in the sampled households were also collected.

3.2 Field survey

The data was collected from a comprehensive field survey with the help of the above-mentioned separate questionnaire for each household. The survey was conducted in the year 2000-2001. The principal women were chosen for the interview because they are most often at home and know more about their household conditions. For getting accurate information the households were visited more than once. Aligarh city comprises of 60 wards and houses 69,797 households (Census of India, 2001). A household consists of all those persons who occupy a housing unit collectively, have one head of the family, put their feet under one table or otherwise join together in an arrangement to provide food, clothing, shelter and other basic residential necessities.

3.3 Statistical analysis

About 30 to 130 households were sampled from every ward of the city. Purposive sampling has been done keeping in mind that the households selected were good representation of persons belonging to different income groups. In this way (3.15 per cent) about 2,185 households were sampled. Further these households were categorized into five income groups (table.1).
Table 1: Household categories based on income in Aligarh city.

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Income (Rupees per month)</th>
<th>No. of sampled</th>
<th>Percentages Households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>&lt; 1,500/-</td>
<td>324</td>
<td>15</td>
</tr>
<tr>
<td>Low</td>
<td>1,500/- to 2,999/-</td>
<td>411</td>
<td>19</td>
</tr>
<tr>
<td>Medium</td>
<td>3,000/- to 4,999/-</td>
<td>620</td>
<td>28</td>
</tr>
<tr>
<td>High</td>
<td>5,000/- to 10,000/-</td>
<td>428</td>
<td>20</td>
</tr>
<tr>
<td>Very high</td>
<td>&gt; 10,000/-</td>
<td>402</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2,185</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: 1$ ~ 48 Indian Rupees  £1 ~ 85 Indian Rupees

The surveyed data was tabulated and simple percentage was calculated. Further the tabulated data was processed in SPSS 7.5 for significance test by Spearman between various household environmental conditions and the respiratory diseases.

4 Results and discussions

Globally the level of morbidity and mortality caused by respiratory illness rivals that from the diarrhea/dysentery. Respiratory infections, which is the second most common cause of death among children in the developing world [16]. It also poses a particular risk to children in urban setting, with overcrowding and air pollution both indoors and outdoors being two significant contributors to this risk. Indoor and outdoor air pollutants can damage children’s lung tissues, predisposing them to viral or bacterial infections [17]. There is also evidence that urban environmental factors associated with lower-income setting that can aggravate, and perhaps even initiate childhood asthma. These factors include indoor pollutants from cooking fires, coal-fired heaters, second hand cigarette smoke, and other sources, as well as allergens associated with dust mites and cockroaches [18-20].

4.1 Household conditions in higher income households and respiratory diseases

The higher income households 38% consist of (20% high and 18% very high income) of the total sampled households table 1. These households are well educated living in the big properly ventilated houses with an average floor area for sleeping per person > 50 square feet. They cook their meal in proper kitchen only on LPG. Nearly 50% of the respondents are smoking indoor normally in their bed rooms. About one third reported of indoor air coming inside the house. This is because they are living in the old parts of the city i.e. in the areas of Upper Kot, Delhi Gate, Delhi Darwaza, Sarai Rahman, and Jaiganj etc. since more than 50 years and some of them live along the main Delhi-Kanpur G.T.
Road on which heavy vehicles ply all day and night. These areas are *Anupshahar Road, Banna Devi, Achal Tal*, and *Ram Gaht Road*. Only about 26% higher income households reported of respiratory diseases in their family table 2.

### 4.2 Household conditions in medium income households and respiratory diseases

The medium income households constitute 28% of the total sampled households. This shows the dominance of medium income group families in the city. About 20% of them have floor space per person in sleeping rooms <10 sq. feet and more than 2/3 do not have the poorer ventilation in their house as well as in the kitchen. 20% respondents cook their meal in the verandah or in their one room accommodation which they use for sleeping table. 2. Thirty five per cent of the respondents cook their food either on wood, coal, saw dust or kerosene oil. It has become increasingly apparent that indoor air pollution is often the source of more personal exposure than outdoor air pollution, especially but not exclusively in homes where bio-fuels are used. While kerosene is generally a less polluting fuel than wood, it is likely to face higher levels of exposure to particulate than LPG, the fuels of wealthy households [10].

More than 65% respondents smoke cigarette/bidi indoor which is one of the major contributing factors for the adverse impact on the health. Nearly 60% households reported of indoor smoke from neighbours, automobiles and industries are coming inside the house. All these factors are responsible for nearly 50% of the respiratory diseases in their family.

### 4.3 Household conditions in lower income households and respiratory diseases

Thirty four per cent households come under this category and their household conditions are very pathetic. More than 60% of very low and low-income households face severe crowding because of lesser space in their sleeping rooms. More than 90% do not have kitchen to cook and they use their multipurpose room for cooking, sleeping, and even bathing table 2. They mainly use wood and dry leaves as the fuel for cooking which they collect from the near by trees. They do not have much money to buy the costly wood for cooking. There is a large share of dung cake also for the cooking in these poorer households. The health of hundreds of million people is threatened in the city area due smoky indoor air caused by the use of smoky cooking fuels such as dung cake and wood [5].

Except few nearly all the households get outdoor smoke coming inside their houses from various sources. This is because they live in the old congested pasts of the city, along the roads and railway lines and also very close to the factories in which they work as labourers to avoid the travel cost. All these factors led to the high share (74% in low and 89% in the very low) of respiratory diseases in these lower income households.
Table 2: Relationship between indoor air quality and the respiratory diseases in the sampled households in Aligarh city. (All figures are in percent.)

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Floor space/person in sleeping rooms</th>
<th>No proper ventilation in the house</th>
<th>Place of cooking (verandah/Multi-purpose rooms/open air)</th>
<th>Fuel for cooking (Wood/coal/saw dust/dung cake/dry leaves)</th>
<th>Indoor smoking</th>
<th>Outdoor smoke coming in from (neighbor/automobiles/Industries)</th>
<th>Total average of six household environmental conditions*</th>
<th>Occurrence of Respiratory diseases*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>66</td>
<td>94</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>96</td>
<td>88</td>
<td>89</td>
</tr>
<tr>
<td>Low</td>
<td>62</td>
<td>90</td>
<td>98</td>
<td>75</td>
<td>89</td>
<td>82</td>
<td>83</td>
<td>74</td>
</tr>
<tr>
<td>Medium</td>
<td>20</td>
<td>69</td>
<td>21</td>
<td>35</td>
<td>67</td>
<td>59</td>
<td>45</td>
<td>49</td>
</tr>
<tr>
<td>High</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>33</td>
<td>33</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Very high</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>50</td>
<td>44</td>
<td>40</td>
<td>58</td>
<td>54</td>
<td>46</td>
<td>48</td>
</tr>
</tbody>
</table>

Source: Field survey (2000-2001)

*Correlation between total average of six household environmental conditions and the respiratory diseases is significant at 1% significance level.
4.4 Relationship between household environmental conditions and respiratory diseases

In view prepared for the World Bank and Habitat about impact on environmental health in the developing countries four environmental factors associated with respiratory diseases were identified [19]:

- indoor population density
- indoor air pollution from the stove used for cooking
- air pollution in the community
- air pollution due to transportation

An epidemiological study on the association between the household environmental conditions and respiratory diseases should cover both environmental factors such as place of cooking food, use of fuel for cooking, cooking particles, ventilation, crowding and other housing characteristics, as well, as confounding factors such as cigarette smoking inside the house [22].

These are more prevalent but there are also some other unidentified risk factors too like duration of cooking, damp houses, use of mosquito coil, and socio-economic status of the household member’s etc. which helps in increasing the disease. Low quality of housing having a leaky roof also facilitates the spread of respiratory infections [2]. The difference in the household environmental conditions gives an explanation for the variation in the respiratory problems among the sampled households belonging to the different income group.

A cross tabulation was done between the six major factors assume to be associated with the occurrence of respiratory diseases table 2. A perusal of this table reveals that there is very high occurrence of respiratory diseases in the lower income households i.e. nearly 89% very low, and 74% low-income households. The conditions in the medium income households in better. While the higher income households do not suffer much due to the respiratory problems. Figure 2 show that moving from lower to higher income the household environmental conditions improves and the trend line of respiratory diseases comes down. The result of Spearman’s correlation further confirms that the correlation between total average of six household environmental conditions and the respiratory diseases is significant at 1% level of significance.

The results corroborate the view that indoor air pollution, crowding and humidity contributes to the respiratory problems. The problems are more severe in the lower income households mainly because of the identified risk factors such as:

- lesser space per person in the sleeping rooms
- no proper ventilation in the house
- cooking meal in the multipurpose rooms
- use of smoky fuels like wood, coal, dung cake, and dry leaves
- out door smokes coming in the house
- indoor smoking
- no proper exit of the indoor smoke
The results further show that the people belonging to poor household who spends more than three to four hours for cooking meal on the smoky fuels are more prone to the respiratory diseases. A very common feature in the poorer families in Aligarh city is that the women take their children of below the age of 5 years in their lap while they are cooking. Hence these small children are more susceptible to the respiratory problems.

5 Conclusions

The study concludes that the respiratory ailments are one of the major diseases in Aligarh city especially for the lower income households, which are due to differences in the household environmental conditions. The disease tends to be associated with income and poverty as well as the living and working environment. A large section of the poorer households (74% in low and 89% in the very low income) are suffering from respiratory diseases. But only 10 to 15 per cent of the high and very high-income households are also suffering from the respiratory problems. They are the parents and grand parents of the rich people and due to the old age they are more at the risk of lungs problems especially when they walk in the smoky neighborhood. With movement of emission controls, two stroke engines, use of cleaner fuel for cooking, use of improved chullahs in the poorer income households, better low class housing facilities etc. the lower and medium income people of Aligarh city can only get some respite from the respiratory diseases.
References


